APPENDIX I

Regulation of Wastewater Reuse and Aquifer Storage and Recovery

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REGULATION OF WASTEWATER REUSE AND AQUIFER STORAGE AND RECOVERY

The state's environmental regulation agency, the Florida Department of Environmental Protection (FDEP), regulates the two water supply alternatives discussed in this section, wastewater reuse and aquifer storage and recovery. The FDEP was formerly the Florida Department of Environmental Regulation (FDER). In July 1993, the FDER was merged with the Florida Department of Natural Resources (FDNR) to form the Florida Department of Environmental Protection (FDEP). This appendix refers to the FDEP except in citations to documents or data published by the FDER.

WASTEWATER REUSE

Reuse is the deliberate application of reclaimed water for a beneficial purpose in compliance with the FDEP and South Florida Water Management District's rules. Reclaimed water is wastewater that has received at least secondary treatment and is reused after flowing out of a wastewater treatment plant (Chapter 62-610, F.A.C.). Reuse includes:

- Landscape irrigation (such as irrigation of golf courses, cemeteries, highway medians, parks, playgrounds, school yards, retail nurseries and residential properties).
- Agricultural irrigation (such as irrigation of food, fiber, fodder and seed crops, wholesale nurseries, sod farms, and pastures)
- Aesthetic uses (such as decorative ponds and fountains)
- Ground water recharge (such as slow rate and rapid rate land application systems)
- Industrial uses (such as cooling water, process water and wash waters)
- Environmental enhancement (such as wetlands restoration)
- Fire protection

The FDER 1992 Reuse Inventory identified 308 wastewater treatment facilities (≥ .01 MGD) that are reusing approximately 290 MGD of reclaimed water in Florida, These facilities have a total design capacity of 601 MGD. This is a substantial increase from the 1990 Reuse Inventory, which identified 199 wastewater treatment facilities that were reusing approximately 266 MGD of reclaimed water (FDER, 1992). Among the many reasons for the increased utilization of reuse are: (1) it is an environmentally acceptable means of disposal; (2) state regulations have been adopted; (3) there is an increased public acceptance; and (4) the frequency of drought and water restrictions have increased. Treated wastewater, when properly treated to acceptable standards for the reuse, is no longer a waste but a valuable nonpotable water resource which will enhance the regional water inventory. Reclaimed water is and will continue to have a substantial role in water supply in Florida.

Reuse in the Planning Area

Eight of the regional wastewater facilities in the UEC Planning Area utilized reuse for reclaimed water disposal in 1993. The methods of reuse employed by these facilities include ground water recharge via percolation ponds, and public access spray irrigation of golf courses, residential lots and other green space. The facilities utilizing reuse for all or part of their disposal needs are listed in Table I-l.

Many of the treatment facilities utilized reclaimed water for plant process water and for irrigation of the plant site, is also could considered reuse. Reuse, which accounted for 3.07 MGD in 1993, accounted for 24 percent of the total wastewater processed in the UEC Planning Area. The remaining 9.98 MGD was disposed of by deep well injection or discharge to surface water and lost from the water supply inventory. This water, that was disposed of by deep well injection and discharge to surface water, could be made available for reuse with the addition of regulatory mandated equipment including filtration and the associated chemical feed system, disinfection facilities and reclaimed water monitoring equipment. A facility reliability of Class I, or an equivalent may exist via their existing method of disposal. In some cases, the existing method of disposal may also be utilized as an alternate means of disposal during periods of low demand or when the required reclaimed water quality is not met, which may negate the need for regulatory mandated storage.

Many of the facilities listed in Table I-l will continue to increase their amount of reuse when additional reclaimed water becomes available and/or when demand is created. Utility-specific information is provided in Appendix E.

Florida's Comprehensive Reuse Program

The State and District objectives include promoting and encouraging water conservation and reuse of reclaimed water. To achieve this objective, several requirements and regulations have been implemented as part of a comprehensive reuse program. These are: (1) Chapter 62-40, F.A.C., (2) Section 403.064, F.S., (3) the FDEP's Antidegradation Policy, (4) guidelines for preparation of reuse feasibility studies, (5) SFWMD Basis of Review, and (6) State reuse regulations.

Chapter 62-40, F.A.C.

This chapter, also referred to as the State Water Policy, requires the water management districts to designate areas that have water supply problems which have become critical or are anticipated to become critical within 20 years. This chapter further states that a reasonable amount of reuse shall be required within these areas. The SFWMD adopted the designated critical water supply problem areas, now referred to as water resource caution areas, by rule (Chapter 403-23, F.A.C.) in October of 1991. The UEC Planning Area is incorporated in this designation.

TABLE I-l. Upper East Coast Planning Area 1993 Reuse Facilities.

Facility	Public Access Spray Irrigation			Percolation Ponds
	Golf Course	Residential Lots	Green Space	
Martin County				
Hydratech Utilities	x			x
Indiantown Company				x
Martin Co. - Port Salerno	x			x
Martin Co. - Martin Downs	x			x
St. Lucie County				
Holiday Pines				x
Port St.Lucie Southport	x			
Port St. Lucie Westport			x	x
St. Lucie West	x	x	x	

Section 403.064, Florida Statutes

This section of the statutes requires all applicants for domestic wastewater permits from the FDEP for facilities located in a critical water supply problem area to evaluate the feasibility of reuse of reclaimed water as part of their application for the permit.

FDEP Antidegradation Policy

This policy is contained in Chapter 62-4, F.A.C., “Permits,” and Chapter 62-302, F.A.C., “Surface Water Quality Standards.” Compliance with the state’s anti-degradation policy must be justified prior to issuance of a permit by FDEP for any new or expanded surface water discharge. The antidegradation policy requires a utility proposing to construct a new discharge or expansion of an existing discharge, to demonstrate that an alternative disposal method such as reuse of domestic reclaimed water is not feasible in lieu of a discharge to surface water, and that such a discharge is clearly in the public interest. This requirement is discussed further in Appendix E.

Reuse Feasibility Studies

There are several rules, statutes, or laws that require preparation of reuse feasibility studies. The FDEP, with assistance from the water management districts and the public service commission, have developed guidelines for preparation of reuse feasibility studies to aid in coordination, consistency and completeness of these studies.

SFWMD Basis of Review

Revisions to the District's Basis of Review, adopted by the Governing Board in October 1992, require feasibility evaluations of reuse. For all potable public water supply utilities who control, directly or indirectly, a wastewater treatment facility, an analysis of the economic, environmental and technical feasibility of making reclaimed water available shall be incorporated into their water conservation plan at the time of permit application.

Applicants for permits for commercial/industrial uses and agricultural, landscape, and golf course irrigation uses which are located in water resource caution areas are required to use reclaimed water in place of higher quality water sources, unless it is demonstrated that its use is either not environmentally, economically or technically feasible. Reclaimed water also has to be readily available for facilities located outside a designated critical water supply problem area,

State Reuse Regulations

The state adopted Chapter 62-610, F.A.C., "Reuse of Reclaimed Water and Land Application," in April of 1989. This Chapter contains the specific reuse and land application requirements of the FDEP and the Local Pollution Control programs where such authority has been delegated to those programs. The chapter is discussed in detail later in this section.

Reuse Benefits

Several benefits result from the use of reclaimed water for nonpotable water needs. When reclaimed water is utilized to replace a potable supply for nonpotable needs, the benefits include:

- Postponement or elimination of future water treatment plant expansions
- Postponement or elimination of construction of additional water supply wells
- Reduction in the size of the potable water distribution lines
- Reduction in monthly water bills

Additional benefits to the above and with respect to other ground water users are:

- Guaranteed source of water
- Reduced demand on the ground- or surface-water resource
- Exempt from water shortage/restriction requirements
- Reduced application of commercial fertilizers since reclaimed water contains nutrients
- More water available and reduced demands during water shortages for the regional water supplier
- Ground water recharge
- Satisfaction of antidegradation requirement for expansion of a surface water disposal facility
- Exempt from SFWMD permitting

Public Health

Health risks with reclaimed water are relative to the degree of human contact and adequacy/reliability of the treatment processes that produce the reclaimed water. The FDEP has developed reuse regulations that require extensive treatment and disinfection to assure that continuous and reliable supplies of high quality reclaimed water are produced to ensure that public health and environmental quality are protected. Each type of reuse is afforded an appropriate level of treatment and disinfection. In addition to extensive treatment requirements, several application site standards must be adhered to which also minimize potential health risks. The Florida Department of Health and Rehabilitative Services has concluded that a reuse facility designed, constructed, and operated to meet the requirements of the state's reuse rules poses no threat to public health (Hunter, 1990).

Regulatory Agencies and Requirements

Reclaimed water treatment, quality and use is regulated by the FDEP. The primary document utilized by the FDEP for regulation of reclaimed water and reuse is Chapter 62-610, F.A.C., "Reuse of Reclaimed Water and Land Application," which was promulgated on April 5, 1989. This chapter contains specific reuse and land application requirements of the FDEP and the Local Pollution Control authority delegated programs providing design, operation and maintenance requirements for land application systems. Chapter 62-610 provides the requirements for reuse via **(1)** Slow-Rate Land Application Systems; Public Access Areas, Residential Irrigation, and Edible Crops; (2) Slow-Rate Land Application Systems; Restricted Public Access, and; (3) Rapid Rate Land Application Systems and Other Land Application Systems. The document specifies the level of treatment required for specific uses of the reclaimed water, the required reclaimed water monitoring equipment, the reliability of the treatment facility, the criteria for the land application system (i.e., golf course, percolation pond, etc.) and system operation. The specific requirements for slow-rate land application systems; public access areas; residential irrigation; and edible crops are located in Table I-2.

In addition to Chapter 62-610, F.A.C., the state has adopted the Wetlands Application Rule, Chapter 62-611, F.A.C., which establishes the foundation and criteria for wetlands receiving reclaimed water.

Reclaimed Water Distribution

Reclaimed water, that has received the required treatment, is delivered to individual users by a dual water system. A dual water system consists of two transmission systems/pipes: One delivers potable water for activities such as cooking, drinking and bathing. The other delivers reclaimed water for activities that do not require potable water, such as irrigation, car washing and industrial uses. Although the reclaimed water transmission system could be designed in several ways and configurations, it is generally one of three basic designs: (1) a low pressure transmission system, (2) a medium pressure transmission system with booster pumps, and (3) a high pressure transmission system. Storage requirements of the system would have to be developed on a case-by-case basis, depending on the design of

TABLE I-2. Chapter 62-610, F.A.C. specific requirements for reuse of reclaimed water and land application for public access areas and edible crops.

Criteria	Requirements
Minimum System Size	- 0.10 mgd FDER rated capacity for slow-rate application in public access areas - 0.50 mgd FDER rated capacity for slow-rate land application on residential properties or edible crops; except for citrus, where the minimum system size can be reduced to 0.10 mgd if the reclaimed water does not contact the fruit, the fruit is processed before human consumption, and public access is restricted
Waste Treatment and Disinfection	Advanced Secondary Treatment - Carbonaceous Biochemical Oxygen Demand (CBOD) ≤ 20mg/L - Total Suspended Solids (TSS) ≤ 5 mg/L - Filtration and chemical feed facilities required High Level Disinfection - No detectable fecal coliform 75 percent of the time with no one sample exceeding 25 colonies per 100 ml
Reliability	- Class I or an equivalent
Monitoring	- Continuous on-line monitoring for turbidity and disinfectant
Storage Requirements	- No storage required if another disposal system is incorporated into system design System Storage - Storage that would be required for a ten year recurrence interval and at a minimum, a volume equal to three times the design average daily flow of the reuse system. Golf course ponds are appropriate for reclaimed water system storage and storm water management provided all Department and District rules are met. - System storage ponds do not have to be lined. Off-Line (Reject) Storage - Minimum volume equal to a one day average daily design flow
Setback Distances Application Site	- 75 feet from edge of wetted area to potable water supply wells - No setback distances to nonpotable water supply wells, surface waters, developed areas, private swimming pools hot tubs, spas, saunas, picnic tables or barbecue pits
Hydraulic Loading Rates	- A maximum annual average loading rate of two inches per week is recommended
Monitoring of Ground Water	- A ground water monitoring program will have to be established for the system

the reclaimed water transmission system and the user's reclaimed water usage schedule. To prevent cross connection, reclaimed water pipes must be color coded or marked to differentiate reclaimed water from domestic or other water.

The low pressure transmission system consists of an open system which delivers reclaimed water at a low pressure 24 hours a day to the user's on-site storage facility (storage tank, pond, etc.). The reclaimed water is repumped by the user when needed. The reclaimed low pressure water transmission system must be designed to meet the peak daily flow because the user's storage facility is filling continuously throughout the day. The operating pressure must be sufficient to deliver water to the user's storage facility for repumping. This system is best suited for large users such as a golf course or industrial facility with ponds or holding tanks to store the reclaimed water until it is needed.

The medium pressure transmission system, with booster pumps, should consist of a closed system to deliver reclaimed water at a pressure, which may be below the minimum pressure requirements of some of the users; the pressure is boosted to meet those user's needs on site. The reclaimed water transmission system must be designed to meet peak hourly flows because reclaimed water should be available on demand. Pressure range for the system is between 40-60 pounds per square inch (psi). This is sufficient pressure to operate most irrigation systems; however, this pressure would have to be boosted to meet the pressure needs of a golf course irrigation system.

The high pressure reclaimed water transmission system is a closed system which is directly connected to, and delivers reclaimed water to the user, at a necessary pressure, to operate the user's distribution (irrigation) system. The reclaimed water transmission system would have to be designed to meet the peak hourly flow since reclaimed water should be available on demand. The system pressure would be approximately 80 psi or higher. Golf course irrigation systems require a pressure of at least 80 psi while residential and other irrigation systems require no greater than 40 psi. This system could include a multi-application reuse system for residential, golf course, park and any other green space irrigation that lacks sufficient space to construct on-site storage facilities.

Potential Uses

Florida's water policy states that water management programs shall seek to "encourage the use of water of the lowest acceptable quality for the purpose intended . . . where economically and environmentally feasible." The District and State support reclaimed water as an appropriate alternate source for irrigation when reasonable and available. There are many uses of reclaimed water as identified previously. A discussion of each follows.

Golf Courses

One of the predominate methods of reuse in Florida is for large-scale irrigation, particularly irrigation of golf courses. Currently, there are approximately 141 golf courses in Florida utilizing reclaimed water for irrigation. In the UEC Planning Area, there are a total of 48 golf courses with a total irrigated acreage of 4,809 acres. The estimated average supplemental (irrigation) water requirements of the existing golf course acreage is about 14 MGD. Potable water is utilized for irrigation by one of these golf courses. The irrigated golf course acreage in the UEC Planning Area is projected to increase to 8,187 acres by the year 2010. The 2010 projected acreage will require an average supplemental irrigation of 27 MGD (see Appendix G for a detailed discussion of demand projections). The golf courses and wastewater treatment facilities in the UEC Planning Area are indicated in Figure I-l. Twenty of these courses utilize reclaimed water for all or a portion of their irrigation. The reuse programs of the Loxahatchee Environmental Control District (ENCON) and Martin County Utilities Dixie Park are examples of golf course reuse systems.

ENCON is a 6.54 MGD wastewater treatment facility located in Jupiter. They provide reclaimed water to nine golf courses in the Jupiter/Tequesta area via a 25 mile distribution network. Many golf courses in the area had drastic reductions in ground water allocations, and the treatment facility was seeking an environmentally accepted means of effluent disposal and a method to enhance the regional water inventory. The first golf course started receiving reclaimed water in 1984 and since then, the response has been overwhelming to the concept (Dent and Davis, 1987). The facility is delivering approximately 4 MGD of reclaimed water to the reuse system.

Martin County Utilities Dixie Park is a 1.5 MGD wastewater treatment facility located in Port Salerno. Currently, the facility utilizes reuse via golf course irrigation and percolation ponds for disposal. The master plan for this facility indicates that five additional golf courses will be served by this facility. By the year 2010, reclaimed water demand is projected to be approximately 3 MGD with a build-out demand of 3.5 MGD (letter dated June 30, 1992 from Orren S. Hillman, Assistant Director, Martin County Utilities, Jensen Beach, FL).

Outdoor Residential

It is estimated that approximately 50 percent of the potable water delivered to single family homes is utilized for outside uses. This can amount to a considerable volume of water treated to potable standards. A substantial savings in potable water, and in turn ground water, could be realized by utilizing reclaimed water for these outdoor nonpotable water uses. These savings may eliminate the need for expansion of existing water treatment facilities, drilling of new wells, or reduce the need for new facilities. The benefit to the consumer in utilizing reclaimed water are lower monthly water bills, reduced need for fertilizer, and exclusion from water shortage restrictions. Some Florida communities which have implemented, or which are proposing to implement, residential reclaimed water systems are St. Petersburg, St. Lucie West, and Boca Raton.

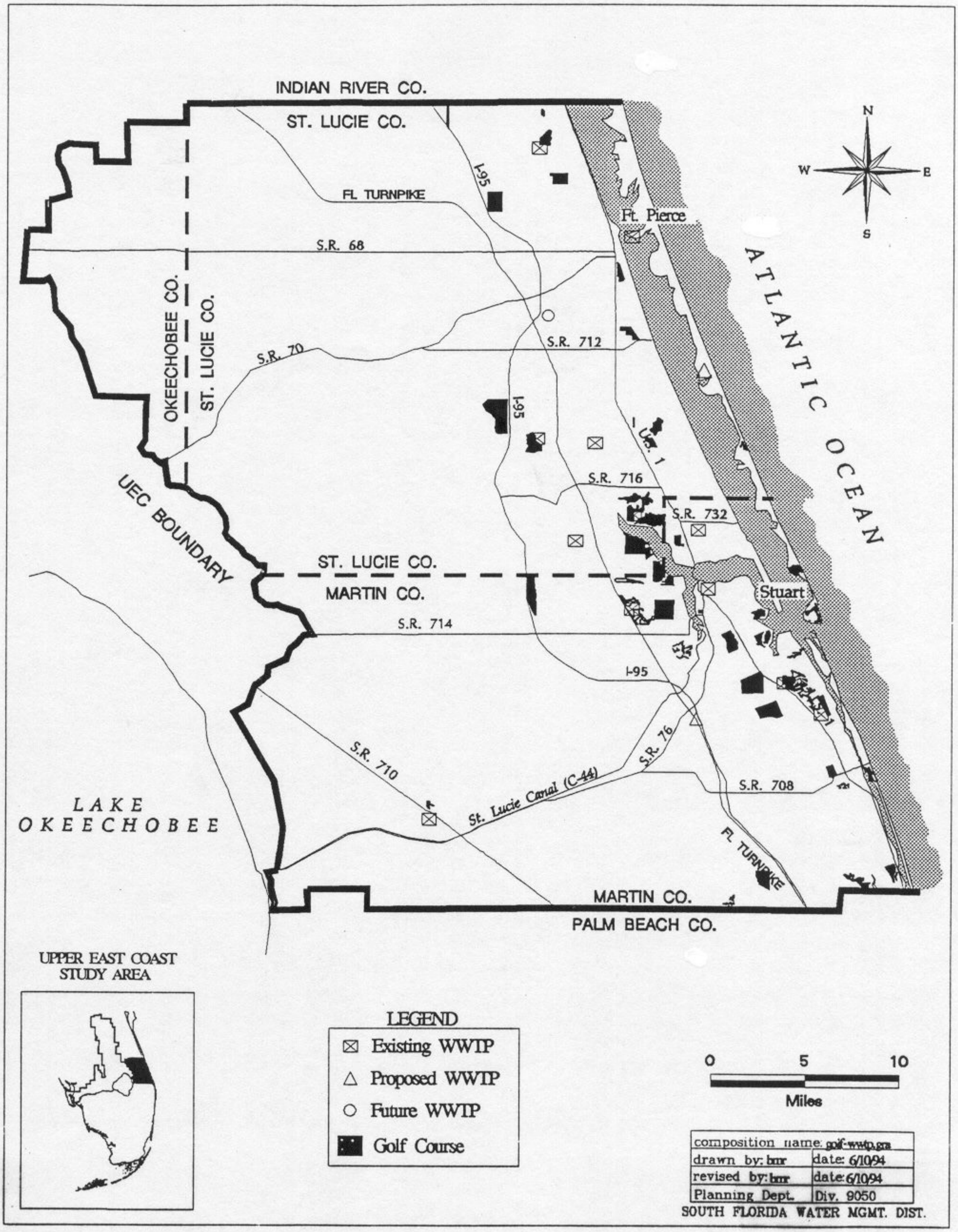

FIGURE I-1. Golf Courses and Wastewater Treatment Facilities.

St. Petersburg has one of the largest urban reuse irrigation systems in the nation. The program was initiated in the mid-to-late 1970s when the city recognized the need to reduce future potable water imports from adjoining counties. In addition, they were faced with required wastewater treatment facility upgrades because of more stringent water quality standards established for Tampa Bay. St. Petersburg was also declared a water short area (Eingold and Johnson, n.d.). Today, the reuse program consists of four treatment facilities with a total rated capacity of 63.4 MGD with approximately 240 miles of reclaimed water transmission main. Deep-well injection systems serve as an alternate means of disposal for the reuse system. The reuse system currently serves 6,570 residential customers among other users. The average daily reclaimed water usage is approximately 21 MGD. It has been estimated that the reuse program in St. Petersburg has extended the capacity of their potable water treatment and supply system by 15 years (phone conversation March 26, 1991 with Joe Towery, Reuse Coordinator, City of St. Petersburg, FL.).

St. Lucie West, located in the City of Port St. Lucie, is a large mixed-use development of approximately seven square miles which was initiated in the late 1980s. During the planning stages of the development, it was identified that the surficial aquifer in the area was very limited. Therefore, a commitment was made to a development-wide wastewater reuse program to conserve this source and provide recharge as well as wastewater disposal. The reuse program will reduce the potable water demand and thus the need for larger water treatment and withdrawal facilities. An extensive dual water distribution system is being constructed as development continues. The system provides reclaimed water for irrigation of golf courses, residential home sites, clubhouse areas, median strips and other green space throughout the development. It is estimated that by the year 2010, the average reclaimed water demand will be approximately 3.5 MGD and at build-out, 5 MGD.

The City of Boca Raton has initated "Project IRIS" or "In-city Reclamation Irrigation System." Project IRIS will be an extensive dual reclaimed water system throughout the eastern two-thirds of the city's service area. It is in this area that reuse will have the greatest impact on potable water consumption and reduction of saltwater intrusion. Boca Raton's 1989 potable water per capita consumption was well over 400 GPD. It was determined 70 percent (280 GPD) of consumption was for outdoor use. There are also several golf courses and other large users with wells for irrigation in this area. Elimination of these wells would also reduce the potential for saltwater intrusion of the freshwater aquifer. It is projected that the wastewater flow in the year 2000 will be 15 MGD, which will be sufficient to supply reclaimed water to the proposed service area. This daily reclaimed water demand will annually conserve three billion gallons of treated potable water and one billion gallons of untreated irrigation water presently withdrawn from the surficial aquifer. With timely implementation, the proposed reuse project will eliminate the need for a 10 MGD expansion of the water treatment plant and related water supply wells, thereby avoiding a capital expenditure of between $7.7 million and $8.7 million. Funding for the project is recommended to come from accumulated water conservation rate funds (Camp, Dresser & McKee, 1990).

Other Green Space

This category includes all other green space that requires supplemental irrigation where use of reclaimed water is desirable. This would include irrigation of parks, activity fields, schools, median strips, cemeteries, commercial landscapes, common areas, and retail nurseries. The Miami-Dade North District has completed construction of a reuse system to provide reclaimed water for irrigation of the 100 acre North Miami campus of Florida International University. The utilization of reclaimed water for irrigation at the campus is estimated to save approximately 70,000 gallons per day of drinking water now being used for irrigation, plus approximately $46,000 per year in water bills.

Agriculture

Agricultural irrigation includes irrigation of food, fiber, fodder and seed crops, wholesale nurseries, sod farms, and pastures. State regulations prohibit direct contact of reclaimed water with edible crops that will not be peeled, skinned, cooked, or thermally processed before human consumption. However, if an indirect reclaimed water-application irrigation method is used (such as ridge and furrow, drip, or subsurface), precluding direct contact of the reclaimed water with the crop, irrigation is allowed. There are several agricultural operations that utilize reclaimed water for irrigation throughout the state, including sites in Tallahassee, Orlando, and Okeechobee and Manatee counties. Citrus, gladiolus, sod, ridge and furrow crops, ferns, hay, corn, soybeans, rye, oats and wholesale nursery plants are some of the crops presently being irrigated with reclaimed water. In 1990, the UEC Planning Area contained approximately 143,000 acres of irrigated agricultural lands. This is projected to increase to 214,000 acres by 2010.

The Conserv II water reclamation facility, located in Orange County, is jointly owned and utilized for reclaimed water disposal by both the City of Orlando and Orange County. Conserv II currently consists of irrigation of 7,000 acres of citrus and 10 acres of ferns plus ground water recharge via 2,000 acres of rapid infiltration basins. This site receives reclaimed water from the City of Orlando Sand Lake Road and Orange County McLeod Road wastewater treatment facilities with rated capacities of 21 MGD and 23 MGD, respectively. Conserv II has a capacity to irrigate 15,000 acres and dispose of 50 MGD (Metcalf & Eddy, n.d.).

Industrial

Potential industrial uses of reclaimed water include cooling, process and wash waters. Potential users include power plants, manufacturers such as metal fabricators and plating, cement makers, commercial and institutional facilities. Facilities in Hillsborough and Broward counties, Tampa and Largo use reclaimed water for industrial uses. Two examples of industrial facilities that utilize reclaimed water are the North Broward resource recovery facility and the Curtis Stanton Energy Center.

The North Broward County resource recovery facility utilizes approximately 2 MGD of reclaimed water from the Broward County North District wastewater treatment facility as cooling water.

The coal fired Curtis Stanton Energy Center power plant in Orange County utilizes approximately 3.5 MGD of reclaimed water from the Orange County Eastern Service Area wastewater treatment facility for boiler cooling water.

Environmental Enhancement

Reclaimed water could be utilized for environmental enhancement in the restoration of hydrologically altered wetlands. There are several wetlands projects utilizing reclaimed water in Florida, two of which are the City of Orlando Iron Bridge and the Orange County Eastern Service Area wastewater treatment facilities.

The Orlando Iron Bridge Regional Water Pollution Control wastewater treatment facility utilizes a man-made wetlands system for reclaimed water disposal. The 1,200 acre created wetlands consist of a deep marsh, mixed marsh, and hardwood swamp. The current flow into the wetlands is limited to 13 MGD, but ultimately the wetland will receive up to 20 MGD of reclaimed water that has received advanced wastewater treatment. From the created wetlands, the reclaimed water flows through the 660 acre Seminole Ranch wetlands prior to discharge to the St. John's River. This system was placed into operation in 1987 (Schnelle and Ferraro, 1991).

The Orange County Eastern Service Area wastewater treatment facility utilizes an overland flow and wetlands system to currently dispose of 3.5 MGD of reclaimed water that has received advanced wastewater treatment. The wetlands system consists of 150 acres of natural wetlands and 150 acres of pine flatwood converted to wetlands which discharges to the Econlockhatchee River. The system will have an ultimate capacity of 6.2 MGD. This system was placed into operation in 1988.

Rapid Rate Land Application

Rapid rate land application involves discharging reclaimed water to a series of percolation ponds or subsurface absorption systems (drainfields). The FDEP requires, at a minimum, that reclaimed water receive secondary treatment and basic level disinfection prior to discharge to a rapid rate land application system. In addition, reclaimed water discharged to subsurface application systems must not contain total suspended solids greater than 10 mg/L. The application rate is limited to 5.6 gallons per day per square foot, unless greater loading rates are justified. There are many rapid rate land application systems in operation in South Florida, mostly associated with reclaimed water disposal from small wastewater treatment plants. However, several large plants utilize rapid rate land application for their primary method of reclaimed water disposal or has a backup to another reuse system.

Hydrodynamic Saltwater Intrusion Barriers

Reclaimed water could be used for ground water recharge in areas of saltwater intrusion. This would be accomplished via rapid rate land application systems or by shallow injection wells. Rapid rate land application such as ponds or drainfields would be strategically placed to deter further migration of the saltwater front. This could be accomplished by constructing long trenches, percolation ponds or subsurface disposal systems parallel to the saltwater front. Injection of reclaimed water by shallow wells has been investigated on Florida's southeast coast. This method of reuse would consist of construction of several injection wells along the saltwater front, which when in operation, would create a positive freshwater head and impede further migration of the saltwater front inland. Injection of reclaimed water is heavily regulated by state and federal agencies. These agencies' regulations prohibit injection of fluids that do not meet applicable water quality standards. Florida Statutes prohibit the direct pumping of reclaimed water into any geologic formation of the Biscayne Aquifer containing less than 500 mg/L total dissolved solids (TDS). Depending on the local geology/geologic profile and the TDS of the formation fluid, various regulations and criteria apply (FDER, 1990).

Reuse Costs and Savings

Costs and savings from the implementation of reuse systems are discussed in this section for wastewater treatment facilities and their customers. Costs are discussed primarily for systems less than 7 MGD because these are the sizes that will most likely be considered by 2010 in the UEC Planning Area. The estimated costs are annualized cost per thousand gallons in 1994 dollars. Annualized costs are presented because they combine the capital and operating costs of the systems. Financing of the capital costs was assumed to be achieved at an 8 percent interest rate over a period of 30 years. Most costs were from earlier years and were updated to 1994 levels using the ENR Engineering News Record (1994) Construction Cost Index.

Reuse Costs

Advanced Secondary Treatment. A cost component common to "public access and edible crops reuse systems" is the requirement for additional wastewater treatment beyond the secondary treatment that is usually provided. This is sometimes called advanced secondary treatment. Generally, filtration with associated chemical feed facilities, high level disinfection and continuous reclaimed water monitoring equipment are required. Engineering cost equations and feasibility studies (Camp Dresser & McKee, 1989) indicate that the annualized costs per thousand gallons for systems less than 7 MGD are generally more than $.10 per thousand gallons and rise significantly to over $.20 per thousand gallons for systems less than 2.5 million gallons per day.

Reclaimed Water Transmission System. Costs include those for the construction, operations and maintenance of the piping and pumping facilities that transport the reclaimed water from the wastewater treatment facility to the user. These total costs increase as the distance the water is transported increases and as the volume increases. However, the increase in costs are less than proportionate such that the larger the volume and the longer the distance, the lower the costs per thousand gallons per mile. The costs also depend on whether the reclaimed water pipes are installed alone or at the same time as other public (sewer or water) works. It is generally much less expensive to complete installations in rural areas than in urban areas. Considerable expense is incurred when waterways, train tracks, interstate highways etc. have to be intersected.

Annualized costs per thousand gallons per mile developed from the Wastewater Reuse System Engineering Cost Model (Camp Dresser & McKee, 1989) show costs per thousand gallons per mile in rural areas varying from $.03 for 6.5 MGD transported 8 miles to $.08 for the same amount transported one mile and from $.07 for 0.5 MGD transported 8 miles to $.15 for the same amount transported one mile. Total transmission system costs (pipline and pumping - capital and operating) for urban areas are about 112 percent of those for rural areas.

Storage Facilities at the Treatment Site. Storage facilities may be integrated into a reuse system for a variety of reasons. Variations in wastewater flows versus reclaimed water demands may necessitate incorporation of storage or regulatory requirements when alternate methods of reclaimed waste/effluent disposal are not available for periods when reclaimed water does not meet the applicable water quality standard (reject storage) or when the reclaimed water demand is less than the wastewater flows. Storage could be provided by above ground storage tanks or by storage ponds. Reject ponds are required to be lined. Data from the Camp Dresser & McKee model indicate that the cost of ground storage tanks would add about $.04 per thousand gallons to a 5 MGD or greater system and over $.10 per thousand gallons for a 1 MGD or less system.

For lined ponds, data from the Camp Dresser & McKee model indicate that the cost is about $.01 per thousand gallons of storage capacity excluding land costs. Obtaining land near an existing treatment plant can be difficult and expensive. On the other hand, land may be available on the plant site that has no other planned use.

Alternate Disposal - Ground Water Recharge Systems. Ground water recharge systems such as percolation ponds or rapid infiltration basins can provide significant aquifer protection and aquifer recharge and wellfield recharge benefits as well as serving as an alternate disposal method to a public access reuse system. Costs of constructing and operating infiltration basins are about $.40 per thousand gallons. Land costs are an additional $.15 to $.40 per thousand gallons depending on the application rates that can be achieved (based on data in CH2M Hill, 1991 and Camp Dresser & McKee, 1989).

Application Area Modifications. Modifications to accept reclaimed water at the user's site could include additional on-site and off-site piping, pumps, ponds and modifications to spray equipment. In a recent survey of reclaimed water users conducted by the Water Management Districts in Florida (KMPG Peat Marwick, 1992) about 60 percent of golf courses responding to the questionnaire reported that modifications to their site were necessary to use reclaimed water. The average capital cost per acre for those reporting these costs was $1,338 (median $740). At the same time 67 percent of agriculture/horticulture respondents reported incurring expenses that averaged $558 per acre (KMPG Peat Marwick, 1992). Using application rates from the same survey, the cost per thousand gallons to finance this investment would be about $.16 per thousand gallons for golf courses (median $.09) and $.07 per thousand gallons for agriculture/horticulture.

Storage Facilities at the Use Site. Storage at the use site is often advantageous since users can integrate the storage area into the existing landscape. Frequently, unlined ponds that are isolated from stormwater systems can be used. Costs to provide on-site storage are included in the broader discussion of on-site modifications.

Reuse Savings

Alternative Effluent Disposal Savings. Alternative effluent disposal costs are a major factor in the costs of reuse systems. A utility can avoid both the capital and the operating costs of alternative disposal methods when the utility is installing new disposal capacity or replacing that capacity. The most likely alternative disposal methods in the UEC Planning Area are deep injection wells or a percolation pond system. As was mentioned above, certain types of percolation pond systems are considered by the Florida Department of Environmental Protection to be reuse systems. Such systems tend to be cost-effective for smaller discharge amounts. For larger amounts, deep well injection is generally used. Where alternative disposal methods are expensive, reuse becomes relatively less costly.

In some cases utilities are asked to consider reuse even when there is existing permitted disposal systems. Operating costs savings of existing disposal systems are achieved for that portion of reclaimed water delivered to the reuse system. Operating costs of deep wells have been estimated by CH2M Hill to be about $.10 per thousand gallons. Annualized capital costs are much larger, on the order of $.30 to $.60 per thousand gallons (CH2M Hill, 1990; Camp Dresser & McKee, 1989).

Alternative Supply Avoidance. The use of reclaimed water saves the customer from paying for an alternative water supply. Most existing irrigation users already have wells or surface intake systems -- the operating costs of these systems is about $.05 to $.10 per thousand gallons. The use of reclaimed water negate these costs.

Fertilizer Value of Reclaimed Water. Reclaimed water contains nitrogen and other nutrients that may substitute for applications of fertilizer. For instance, if the reclaimed water contains .08 pounds of nitrogen per thousand gallons and the nitrogen in fertilizer costs $210 per ton, then the reclaimed water would have a fertilizer value of $.008 per thousand gallons. In some situations, both fertilizer cost and application costs may be reduced. This value does not seem to be recognized by users. Only one user in the survey indicated cost savings due to reductions in fertilizer applications after switching to reclaimed water (KMPG Peat Marwick, 1992).

AQUIFER STORAGE AND RECOVERY

Regulatory Criteria

Guidance for preparation of Class V Aquifer Storage and Recovery injection well system permit applications is provided in a document titled "Guidance for Development of Class V Aquifer and Storage and Recovery Injection Well Systems in South Florida – November 1993" (U. S. Environmental Protection Agency, 1993). This document was prepared by the South Florida Aquifer Storage and Recovery Work Group, which consisted of representatives from the U.S. Environmental Protection Agency, Florida Department of Environmental Protection and the South Florida Water Management District. The following are excerpts taken from that document.

Background

This section outlines circumstances in which a Class V permit would be needed. Aquifer Storage and Recovery (ASR) is the "emplacement of water through the use of an injection well into a suitable aquifer during periods of excess water supply for later retrieval and use during periods of need." Traditionally, public water supply systems employ ASR to store finished drinking water for later recovery and use. ASR can also be used to store excess wet season surface water for later recovery during the dry season as needed to augment drinking water supplies and for other uses, such as agricultural irrigation.

A major impediment to implementing ASR is that the Underground Injection Control (UIC) regulations prohibit injection of fluids into underground sources of drinking water (USDW) if the fluid contains contaminants which violate any federal primary drinking water standard or may adversely affect the public health. If the proposed ASR project will violate any of these criteria, an aquifer exemption must be obtained. This may be difficult to justify in many areas due to the quality of the receiving aquifer (3,000-10,000 mg/L total dissolved soils) and the proven use of reverse osmosis technology in producing drinking water from aquifers of this quality. In addition to meeting the federal primary drinking water standards, Florida's ground water and UIC rules require that all fluids injected into a USDW meet the secondary drinking water standards and minimum criteria. There are, however, state mechanisms which may be used to grant relief from these requirements when appropriate. A costly way to resolve this dilemma is to treat the surface water to the appropriate standards prior to injection. An alternative may be to inject the water into a deeper portion of the aquifer which contains a total dissolved solids (TDS) concentration of more than 10,000 mg/L. The state has limited experience regarding the success or feasibility of recovery from such zones.

Aquifer exemptions represent major or minor modifications to State UIC programs depending on the level of TDS in the aquifer. If the aquifer which is to be

exempted contains water with a TDS concentration of less than 3000 mg/L a major modification is required. Major modifications require notice in the FEDERAL REGISTER and a minimum 30-day public comment period. The state of Florida was delegated primary program responsibility (primacy) for implementing the federal UIC program and follow this process.

Minor exemptions require a more limited public notice but still may be difficult to obtain. Under the current state UIC rules only minor exemptions (3,000-10,000 mg/L TDS) are allowed.

Although ASR is generally considered to be a beneficial use of underground injection, concerns with its use include treatment costs, the classification of the ground water and competing uses for the aquifer. Ground water is classified under Chapter 62-520.410, F.A.C. The fluid injection for storage must meet applicable water quality standards according to the classification. Water may have to be treated to acceptable levels prior to injection. Depending on the source of the water to be stored, treatment costs could be excessive. Also, application of the drinking water standards does not give credit for pollutant reductions obtained from the ASR injection process (i.e., bacteria die-off, phosphorus reductions). Current laws do not provide flexibility for addressing this issue.

In some cases, the receiving aquifer for an ASR project is the same aquifer that is being used to monitor for fluid movement at a Class I injection facility. If the ASR and Class I facilities are in the same area, the use of the aquifer for Class I monitoring may be impaired. If this is the case, it may not be possible to obtain an ASR permit in area where a Class I injection well systems is located. A case-by-case evaluation is therefore essential.

Types of ASR

There are three basic types or uses for ASR: (1) ASR used to provide potable or drinking water during times of peak demand; (2) ASR used for storaging raw ground water; and (3) ASR used for storaging surface water.

Potable or drinking water during peak demand.

Public water supply systems can employ ASR to store finished drinking water for later recovery and use. Water is treated to drinking water standards, stored in the aquifer, and later recovered for use during periods of peak demand.

This is the most common use for ASR. In particular, it is a major benefit to water treatment plants at or near capacity. Stored water can be used during periods of peak demand, reducing the need for increasing plant production capacity. ASR also reduces the impacts on natural systems during peak demand times, particularly when peak demands occur during times of drought.

ASR can also be used as a water storage method to provide an alternative water supply in coastal areas for potential use during emergencies or when regular facilities are not operating. This method can be particularly valuable as a readily available local source of water in emergencies where water lines are destroyed preventing access to regional water supplies (i.e., the Florida Keys). However, disadvantages include costs of establishing the services (capital expenditures) and the unknowns associated with planning for such emergencies.

Raw Ground Water ASR

ASR may be used where untreated ground water is stored in an aquifer for later recovery. The advantages of using ground water is that the quality of ground water is less variable over time than surface water, thereby potentially reducing treatment costs. In cases where the ground water quality is good, treatment may not be needed. Limitations include the limited sites available for use and the need to evaluate the water quantity and quality impacts on the natural systems and other users of the shallow water aquifer from which ground water is being withdrawn.

Surface water ASR

Treated or untreated surface water is stored in an aquifer for later recovery and use. Specific uses of surface water ASR include salinity control, agriculture, and as a storage option for urban supply. This method could potentially reduce treatment needs and provides a conservation tool for water quantity (back-up systems), providing recycling benefits, and reducing evaporation losses. It conserves water that would be lost to runoff and can be used later for water supply or natural systems. However, treatment may be required to meet UIC regulatory requirements or an aquifer exemption may be needed.

Project Feasibility

An ASR project must be evaluated in terms of its technical, environmental and economic feasibility. The technical valuation should include a discussion of the appropriateness of the receiving aquifer and address the adequacy of aquifer storativity and transmissivity.

Where applicable, the following environmental effects must be examined: adverse impacts on adjacent aquifers, the lateral and vertical extent of the water quality impacts, effects on nearby surface waters and saltwater intrusion concerns. The effects of the ASR project on existing uses of the aquifer system must also be examined (i.e., monitoring zones associated with existing Class I and Class V wells, existing sources of potable water).

Economic considerations to the facility and the community should be identified, evaluated and discussed. The costs of initial injection and monitor well construction, operation and maintenance (including mechanical integrity testing and ground water monitoring) should be considered when determining project feasibility.

Advantages and Disadvantages of ASR

The following are potential advantages and disadvantages of ASR:

<u>Advantages</u>

- Small-scale land acquisition required, compared to surface water storage
- No loss of water to evaporation, as compared to surface water storage, where evaporation losses can be significant
- Ability to locate an ASR facility at the point of need
- Use of recovered water during the dry season does not adversely affect the

surficial aquifer, water conservation, or wetlands

- Improved reliability of the utility system in the event of an emergency or drought

Disadvantages

- The quantity of water recovered may be less than the amount injected due to the degradation of the stored water over time
- Increased well maintenance may be needed – formation of deposits, which result from mixing of chemically dissimilar waters, is accelerated
- Initial start up cost for an ASR well is expensive compared to a surficial well – an ASR well requires greater depth and has more stringent well construction design criteria

Existing ASR Facilities

Manatee County. In 1978, Manatee County began treated water ASR investigations in cooperation with the Southwest Florida Water Management District (SWFWMD) and CH2M Hill Engineers. This program start up was a direct result of a 1976 CH2M Hill project for Naples, Florida which included two shallow connector wells that recharged the local production zone by gravity from the overlying water table.

The Manatee County Utilities Department has a surface water treatment plant that operates at 54 MGD adjacent to Lake Manatee, which is an impoundment on the Manatee River. An investigation of an artesian limestone

aquifer beneath Lake Manatee was conducted which evaluated aquifer hydraulic characteristics such as transmissivity, storativity and leakance. After a series of injection and recovery tests were conducted to determine water quality and percent of water recovered, it was concluded that Manatee County could meet peak water demands as high as 70 MGD without expanding their water treatment plant. The ASR facility is currently in operation, with a rated storage capacity of 316 million gallons. At the end of 1993, 294 million gallons were in storage in the aquifer (phone conversation January 6, 1994 with Bruce McCloud, Manatee County Utilities, Bradenton, FL.).

Peace River. A 12 MGD surface water treatment plant built by General Development Utilities, Inc. (GDU) supplies water to Port Charlotte. Port Charlotte's source of raw water is the Peace River (now owned and operated by the Peace River/Manasota Regional Water Supply Authority). Due to variations in both water flow and water quality of the river, including occasional movement of saltwater upstream of the plant intake, a 1,920 acre-foot capacity offstream reservoir was constructed for raw water storage. In 1984, GDU was faced with the need to expand their water storage capacity, and as a result, treated water ASR was examined as a potentially less expensive storage option. Two potential production zones were tested to determine if treated water ASR was feasible. Six ASR wells were installed which provide a treated water expansion of 4.9 MGD. Three additional wells are planned for feasibility testing in 1994 (phone conversation January 6, 1994 with Grady Sorah, Peace River/Manasota Regional Water Supply Authority, Port Charlotte, FL.). Over the next 30 years, ASR is expected to reduce capital investment for water supply and treatment facilities for the Peace River by over 50 percent.

Cocoa. The Floridan Aquifer System (FAS) is the source of well water for the Cocoa service area. The wells are located inland as far as 50 miles from some locations in the service area. This great distance is due to saltwater intrusion which is occurring along the coast. The Claude H. Dyal water treatment plant has a capacity of 40 MGD. In 1987 demand had reached 37 MGD, which prompted the City of Cocoa to investigate the potential for treated water ASR as an alternative to water treatment plant expansion.

The success of this test program allowed Cocoa to proceed with treated water ASR and defer a water treatment plant expansion. The system was permitted in 1991 and presently operates at a maximum permitted recovery rate of 8 MGD, utilizing 6 ASR wells (phone conversation January 6, 1994 with Glenn Loffler, Claude Dyal Water Treatment Plant, Cocoa, FL). Present indications are that plant expansion can be deferred until maximum day demand reached 50 MGD, but an expansion of raw water supply will be necessary to sustain increases in average withdrawals.

Port Malabar. In 1987, the Palm Bay Utility Corporation at Port Malabar began treated water ASR investigations. The Port Malabar development is within the city limits of Palm Bay on the east coast of Florida and obtains its water supply from an intermediate aquifer. At the time the ASR investigation began, water demands were approaching the water treatment plant capacity of 6 MGD and were, at times, equal to wellfield supply capacity. If the treated water ASR project investigation proved successful, it would help Port Malabar meet its upcoming seasonal and daily peak demands and defer water treatment plant expansion.

A test facility was constructed within the Port Malabar distribution system. This location enabled the recovered water to be put directly into a nearby transmission main. The treated water ASR facility was tested and the recovered water met all drinking water standards and required no retreatment other than disinfection. Today, the Port Malabar ASR facility is fully operational and provides an additional 1 MGD of treated water supply during peak demand months.

Boynton Beach. In late 1992, the city of Boynton Beach began testing of its ASR facility. During the wet season, treated ground water from the Surficial Aquifer System is pumped into the upper portion of the Floridan Aquifer System for storage. Upon recovery, the water is filtered and rechlorinated, then used to augment the public water supply during dry periods and during peak demands. This serves to alleviate stress on the Surficial aquifer System which is susceptible to saltwater intrusion.

During a dry spell in May 1993, about 17 million gallons of water were recovered from the ASR system. The single ASR well can provide 2,000 GPM of recovered water, although the city is still gathering information. As of early 1994, five injection/storage/recovery cycles had been completed (phone conversation January 6, 1994 with Peter Mazzella, City of Boynton Beach Utilities, Boynton Beach, FL.).

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